

LECTURE
ON
INSULAR FLORAS

*DELIVERED BEFORE THE BRITISH ASSOCIATION
FOR THE ADVANCEMENT OF SCIENCE AT
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BY

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INTRODUCTORY NOTE

THE following is the substance of a Lecture delivered before the British Association for the Advancement of Science, at Nottingham, on the 27th of August 1866. It is a mere fragment of the subject its title indicates, treating, and in outline only, of but a very few of those groups of oceanic islets, the Floras of which have long engaged my attention. The gratification which the favourable reception of this lecture afforded me has something to do with my wish to extend a knowledge of it; I may, however, further plead other motives, as the wishes of many friends who did or did not hear it; and one unexceptionable one—a desire to see its statements and methods investigated by others, and more facts accumulated, which would much aid me in my project of treating the whole subject of Oceanic Floras comprehensively at a future time.

INSULAR FLORAS

THE subject which I bring before you to-night is that of Insular Floras, in their relations to one another and to the great continents from which they have or appear to have derived their plants. And as my treatment of the subject is partly descriptive and partly theoretical, I have cast it in the form of a written discourse.

I must warn you that the term "Insular Floras" is a technical one, and, like so many technical terms, is apt to mislead till explained. In a botanical sense I have limited it to the Floras of those islets that rise as mere points of land from out the broad breasts of the great oceans. With few exceptions all are volcanic, all mountainous, and so small that no man has realised their smallness who has not sailed in search of them.

Our largest maps of the world give us no idea of the diminutive size of such islets as Madeira and St. Helena, any more than Bradshaw's map gives any notion of the size of the railway lines as compared with the counties they traverse. The only contrivance I know of that ever did give me an approximate idea, was Wyld's Great Globe in Leicester Square. This was owing partly to the great scale of that admirable contrivance, and partly to the omission of names—names which sprawl over more degrees in our maps, than the islets themselves occupy seconds.

The relationships between these oceanic island Floras are of

two kinds, that must not be confounded: one a relationship of analogy between themselves, due to physical conditions common to them all—to their climate, exposure, limited area, distance from continents, &c. Thus they are rich in Ferns, Mosses, and other Flowerless plants; and they possess many evergreen, but comparatively few herbaceous plants, and fewer or no indigenous annuals. Plants which are herbs on continents, often either themselves become shrubby in islets, or are represented by allied species that are shrubby or arboreous. Species are few in proportion to genera, and genera in proportion to orders. The mountains, however lofty, present few alpine or sub-alpine species; and the total number of species is usually small compared with what continental areas of equal size and similar conditions contain. The other is a relationship of affinity, a *bonâ fide* kinship, which the Floras of islands display in common with one another or with certain continents: as is shown by Madeira, the Azores, and Canaries containing many plants in common that are not found on any continent; by the Canarian Flora being in the main a Mediterranean one; the St. Helenan being an African, and so forth. It is with the consideration of these affinities that I shall occupy your attention to-night.

But before proceeding to abstract considerations, it may help you to a clearer insight into my subject if you will voyage in imagination with me over some of the great oceans, visit a few groups of their islands, and look with me upon the principal features of their Floras.

It was my good fortune to be attached, early in life, to one of those expeditions of discovery that have added so much to the naval renown of our country. This was the Antarctic Expedition of Sir James C. Ross, which originated with the British Association of 1838, held at Newcastle, and which circumnavigated the globe for the double purpose of making magnetic observations, and prosecuting geographical discovery in high southern latitudes. These objects required our visiting many oceanic islands, including some of the

most remote and inaccessible, a circumstance which gave me a special interest in these Floras.

And for the purpose of better illustrating the subject, I have here hung before you Sir Henry James' new 10-foot projection of two-thirds of the sphere on a plane, which includes all the islets whose Floras I shall touch on to-night. This map is constructed so as to carry out the idea of looking at a globe from the inside. The eye is supposed to be directed towards Central Africa, not from the centre of the sphere, but from a point so far in the opposite direction to Central Africa that two-thirds of the sphere is embraced by the vision. By this arrangement you will see that the relative positions of the islands and continents in the Atlantic and Indian Oceans, with whose Floras I shall have to do this evening, are represented more truly in position than in a Mercator's or other projection; but on the other hand, that the bounding countries of the chart are much distorted. These islets are the Madeiran, Canarian, Azorean, and Cape de Verd groups; St. Helena, and Ascension—all in the Atlantic; and Kerguelen's Land in the South Indian Ocean.

Let us commence with the Atlantic Ocean and the MADEIRAN GROUP, consisting of Madeira, Porto Santo, and the rocks called Dezertas.

On landing we are at once struck with the European character of the vegetation, and though exotic plants abound, as some Palms, the Orange, Banana, Sugar Cane, &c., it is wonderful with what ease we distinguish between the indigenous or naturalised European element, and the cultivated and semi-naturalised exotic.

But though the vegetation is European in the main, it is not so altogether, and even its European features soon arrange themselves in a botanist's eye under different categories, very much as follows: The majority, including almost if not all the annuals, we find to be identical with European plants, and undistinguishable from them; others

- differ from European plants by slight but certain characters, as varieties we say; a third class are specifically different from European, and yet seem to hold a place corresponding to what their nearest allies occupy in Europe—these are representative species; and a fourth class comprises plants that are evidently allied to European, but belong to different genera—these constitute representative genera.

Now, it is a curious fact, that when we tabulate these classes, we find that to a great extent they form a graduated series, not only in systematic order and structure, but in point of numbers; in other words, the plants identical with those of Europe are both the most numerous in species, and the species are most numerous in individuals: then come the varieties—some are scarcely perceptibly different from European plants, others constantly, and these are less numerous and less common. Then come the distinct species: of these some would be called varieties by many botanists, and others good species by all; these are still less common. Lastly, of the different genera, some constitute what all botanists call a good genus, others would, with some botanists, take rank as slight modifications of European genera; these are both the fewest in number and most local in distribution, many indeed being confined to single spots, or even represented by single plants.

So much for the European element of the Flora.

Take now the separate islets of the group: Porto Santo is only 30 miles from Madeira itself, and the nearest of the Dezertas 15; yet we find that these islets not only differ materially in their Floras from the main island, but from one another, in species, varieties, and even in genera.

On penetrating to the rocky and precipitous interior, whether of the main island or the smaller, we find many indigenous trees and shrubs that are not only foreign to Europe, but are allied to American, to African, and to Asiatic plants: thus we have trees of *Clethra* and *Persea*, genera found in no continent but America; of *Apollonias*

and others found elsewhere on a continent only in the East Indies; and of *Dracæna* and *Myrsine*, that betray an African affinity. As these non-European plants inhabit the Canaries and Azores also, they have been called *Atlantic types*, under which name I shall speak of them.

Lastly, when we ascend the mountains of Madeira above 4000 feet and up to their summits (6000), we find little or none of that replacement of the species of a lower level by those of a higher northern latitude, with which we are so familiar in ascending any continental mountains of equal or less height. Plants become fewer and fewer as we ascend, and their places are not taken by boreal ones, or by but very few.

Here then are various botanical features in respect of which Madeira and its satellite islands, Porto Santo and the Dezertas, differ very much from continental areas of equal extent and elevation, or from islands lying near the coast of a continent, the Floras of which are therefore continental.

Let us take Great Britain as a standard of comparison. Great Britain contains twice as many flowering plants as the Madeiran group; but these are, with scarcely an exception, identical with continental European; it contains but few varieties differing from those of the neighbouring continent, and only one indigenous non-European genus, which is an American water plant (*Eriocaulon*). Moreover, on ascending above 2000 feet, a rapid replacement of species succeeds.

And so it is with any other corresponding area in Europe: none present a similar assemblage of Asiatic and American plants, nor an equal number of peculiar varieties, species, and genera, as the Madeiran group does, nor so many peculiar plants represented by so very few specimens; and nowhere do we find the rocky islets on the coast of a continent to be tenanted by numerous singular genera, species, and varieties, which are to be found nowhere else on the surface of the globe. What should we say, for instance, if a plant so totally unlike anything British as the *Monizia edulis* (an Umbelliferous plant, with a stem like an inverted elephant's trunk,

crowned with a huge tuft of Parsley-like foliage), were found on one rocky islet of the Scillys, or another Umbelliferous plant (*Melanoselinum*) with a slender trunk like a Palm, on one mountain of Wales; or if the Isle of Wight and Scilly Islands had varieties, species, and genera too, differing from anything in Britain, and found nowhere else in the world!

Of all the above peculiarities, it is those very rare and local plants that are isolated as genera, and in geographic distribution, that arrest the inquirer's attention and force him to speculate. We *must* ask ourselves, were these almost unique isolated individuals created as complete highly specialised organisms, or are they modifications of allied plants, owing their strange forms and special attributes to centrifugal variation operating through countless ages? and however they have originated, are we to regard these solitary representatives of such strange forms of vegetation as the first of their several races, destined, mayhap, to increase, and become in future as common as they are now rare; or the last of their races, which, but for the rapid advance of modern science, would have passed away, along with those countless forms of animal and vegetable life that once peopled the globe, but whose forms and structures will never be revealed to us?

Considerations, which I cannot here enter into, warrant our belief that such plants on oceanic islands are, like the savages which in some islands have been so long the sole witnesses of their existence, the last representatives of their several races; and the question involuntarily arises—How did this come about?

Excluding the direct agency of man, and of animals introduced by man, I believe that a principal cause of the rarity or extinction of old species on oceanic islands is the subsidences they have all experienced. This sinking of the island operates in various ways. 1. It reduces the number of spots suitable to the habits of the plant. 2. It accelerates that struggle for existence which must terminate in the

more hardy or more prolific displacing the less hardy or less prolific. 3. It reduces both the numbers and kinds of insects to whose activity the fertilising process in plants, and hence their propagation, is so largely due; and not only does it reduce the numbers and kinds of insects, but the destruction falls heaviest on the winged kinds, which, as has lately been shown, are almost exclusively the agents in this process; for these, as the area becomes contracted, are blown out to sea and lost in greater proportion than the wingless. Nor is this mere conjecture. Mr. Wollaston's careful entomological researches in Madeira and the Canaries prove that winged insects exist in wonderfully smaller proportions to wingless, in these islands, than on the continents, and I can extend this observation to other oceanic islands that I have visited.

But in Madeira the agency of man must not be overlooked. The natural history of that lovely island has undergone such a revolution within the last 400 years, as under the ordinary operations of Nature can only be measured by the geological chronometer. In the romantic story of its first discovery, it is stated to have been covered with wood, whence its Portuguese name of Madeira, and this is confirmed by the first settlers, who found the forests to be impenetrable, so that they set fire to them, and a conflagration ensued which lasted seven years. Cultivation and the introduction of European trees followed; and who now can form a conception of the number of peculiar plants that utterly perished in the flames, or that have since been elbowed out by the more vigorous introduced European vegetation? And with regard to P'orto Santo, in about the year 1418 a mother rabbit and her brood were landed, and increased so rapidly, that they not only consumed the native vegetation, but the cultivated, and actually drove the settlers from the island.

Such catastrophes help us to account for the rarity of many of the species, but not of those that inhabit the tremendous scarped precipices of the coast and interior, which are equally inaccessible to man and fire; nor of those of the outlying

islets. For such, and for the presence of the Laurels and other plants of the Atlantic island type, as contradistinguished from European, we must seek other and far different explanations, which we shall best understand after visiting other oceanic islands.

The CANARY ISLANDS form a much larger and more important Archipelago than those of Madeira, are situated 300 miles further south, and are much nearer the African coast, and yet their Flora is not that of Africa, and indeed contains comparatively very few of the plants of that continent.

The Canary Islands contain upwards of 1000 native species, of which fully one-third are absolutely peculiar to the group, and these admit of almost precisely the same classification as the Madeiran plants. Thus, the mass of the plants are identical with Mediterranean species; then follow, in numerical importance, those that are representative, as slight or well marked varieties, or congeners or co-ordinates of the Mediterranean genera and species. After these come, and in great force, the Atlantic plants, including no less than forty of the Madeiran shrubs and trees that are not found in Europe or Africa, and as many representatives of Madeiran genera, species, and varieties, together with a number of allied ones more nearly related to African, Indian, and American plants than to European. Lastly we have, as was to be expected, a sprinkling of African plants, belonging to that division of the African Flora, which, being different from the Mediterranean on the one hand and from the Equatorial African on the other, extends from Western Asia through Arabia and across the Sahara to Cape Blanco—a Flora conterminous in longitude with the distribution of the domesticated camel, which is used as a beast of burthen even in the Canary Islands. This Flora I would call the Arabo-Saharan.

The lofty mountains of the Canaries, though upwards of

11,000 feet high, contain no alpine plants, and as in the case of the Madeiran group, many of the most peculiar forms are extremely rare and local. Lastly, the Floras of the several islets of the group differ much from one another. The two easternmost, Lancerote and Forteventura, especially, thus standing in the same relation to the others, that Porto Santo and the Dezertas do to the main island of Madeira.

It is not necessary to do more than thus broadly sketch the general features of the Flora of this group, to show you what a parallel it exhibits to the Madeiran, and how intimate their original botanical connection must have been.

And that this connection was something more than a botanical one is proved, by the examination of some rocky islets, that scarcely emerge 100 feet above the surface of the Atlantic, almost midway between Madeira and the Canaries; these are the rocks called SALVAGES, of which one, that is I believe barely a mile long, is covered with a scanty vegetation. It were natural to suppose that this isolated rock at least would have been peopled by migration from the African coast, but it is not so. My friend the Rev. Mr. Lowe, who has spent many years in botanising in the Madeiran and Canary Islands, is the only naturalist who has ever visited these storm-beaten rocks. This he did last year, and he informs me that they contain an Atlantic Flora, and one intermediate in character between that of Madeira and the Canaries, but most closely related to the latter. The Salvages hence appear to be the peaks of a submerged island that once occupied an important botanical as well as geographical position in the Atlantic Ocean, more or less closely linking the Canaries with Madeira. It is impossible otherwise to explain its colonisation by these insular oceanic types that are equally foreign to Europe and Africa.

The AZORES ISLANDS are the third great North Atlantic group and demand more special notice, because of their remoteness from any continent. This archipelago is 740 miles distant

from Portugal, 1035 from the nearest American land (Newfoundland), and almost double that distance from the American States in the same latitude as itself. They are 500 miles from Madeira.

Of flowering plants 350 species have been collected from the principal islands, a very small number considering their extent, but enough to give us a clear insight into the nature of the Azorean Flora. Of these some thirty are peculiar species or well-marked varieties, representatives for the most part of Madeiran or European plants. About thirty are Atlantic types, common to the Azores and Madeira, or to the Azores and the Canaries, or to all; the rest are Portuguese and Spanish plants. Thus, though the absolute number of plants foreign to Europe is even less than in the Canaries and Madeira, these hold a far more important position in the whole Flora, from including so many of those peculiar Atlantic trees and shrubs that link all these three groups into one well-marked though fragmentary Flora.

Though so much further north than Madeira, the Azores contain scarcely any more boreal plants than Madeira, or even than the Canaries; and such as it does possess are likewise found in the mountains of the Spanish Peninsula. The most notable are the common Ling or Heather (*Calluna vulgaris*), and the beautiful St. Dabeoc's Heath, which is elsewhere found only in the extreme west of Ireland, and in the Pyrenean region. A third is *Littorella lacustris*, a little water plant that inhabits a mountain lake, probably the crater of an extinct volcano, much frequented by migratory water-fowl.

As in the other groups, there is here a considerable difference between the Floras of the separate islets; and one of the most conspicuous and beautiful plants in the Azores, the *Campanula Vidalii*, is (so far as is known) absolutely confined to a single sea-girt rock off the east coast of Flores. This plant was never gathered but once, by Captain Vidal, whose name it bears, during his survey of the island some

twenty years ago. Captain Vidal's survey was most fortunately accompanied by a scientific botanist, Mr. H. C. Watson, who both named this remarkable plant, and sent seeds of it to Kew. From these seeds the plant has been propagated, and there are now probably a thousand-fold more plants of it in the greenhouses of England than exist in its native locality!

Considering how far removed the Azores are from Europe, and how much nearer they are to America than Madeira and the Canaries are to that continent, it might appear strange that the group contains scarcely any American plants not found in the other groups. But such is the case, and more than this; for even the *Clethra* of the Canaries and Madeira, a genus found nowhere else out of America, does not inhabit the Azores.

The only trace of American influence on the Azorean Flora that I can substantiate, is in a species of the Umbelliferous genus *Sanicula*. Of this genus a common European species is spread almost all over the globe, inclusive of Madeira and the Canaries, but exclusive of the Azores; whereas another species of this same genus takes its place in the Azores, and this species is most closely allied to an American one.

It is a significant fact, that the minute seed-vessels of *Sanicula* are provided with hooked bristles, suggesting the probability that these were originally transported by birds across the Atlantic.

I may add that the large Bean-like seeds of *Entada*, a West Indian climber, are thrown up abundantly on the islands by the Gulf Stream, but never grow into plants, if indeed they ever germinate on their shores. Some years ago a box of these seeds from the Azores was sent to Kew, where many germinated and grew to be fine plants, showing that their immersion during a voyage of nearly 3000 miles had not affected their vitality.

Another group of Islands, far distant from the above,

demand a passing notice, as they have been regarded by some botanists as members of this Atlantic Flora. These are the CAPE DE VERDS, situated far within the tropics, 800 miles south of the Canaries, and 300 distant from the African coast.

I visited this group in 1839, and found the Flora of the lowlands to be purely African and Arabo-Saharan in character, but on ascending the mountains, I met with a few plants very characteristic of the Canaries and Madeira. The Rev. Mr. Lowe has during the last two winters diligently botanised this group, with most interesting results. He finds, as I did, that the mass of the Flora is African, and that the mountains contain many Canarian types; but that all these are the types that have representatives in the Mediterranean region, whilst of those peculiar Canarian, Madeiran, and Azorean plants that have no near allies or representatives in Europe, not one is found in the Cape de Verds, with the single exception of the Dragon's-blood tree.

Also, ascending above the tropical zone to 5000 feet and upwards, many of the same middle-European plants are found, that appear at correspondingly lower elevations in Madeira, the Canaries, and Azores, and I may add that these are also found on the lofty mountains of Equatorial Africa and Abyssinia.

We have thus in the Cape de Verd Islands a certain relationship with the Canaries and Madeira almost to the exclusion of the Azores; but it is a feeble one, and so blended with that of the African continent, and especially of the Mediterranean region, as to suggest other considerations than what concern us here.

ST. HELENA.—The botanical history of this speck in the vast Atlantic Ocean is a most curious and instructive one. It lies in lat. 16° S., is 1200 miles from Africa, 1800 from America, and 600 from Ascension, its nearest land; it is only about ten miles long, by seven broad, and rears itself

out of the ocean, a black pyramidal volcanic mass, girdled with beetling sea-cliffs, that are cleft by narrow ravines. When discovered, about 360 years ago, it was entirely covered with forests, the trees drooping over the tremendous precipices that overhang the sea. Now all is changed, fully five-sixths of the island are utterly barren, and by far the greater part of the vegetation that exists, whether herbs, shrubs, or trees, consists of introduced European, American, African, and Australian plants. The indigenous Flora is almost confined to a few patches towards the summit of Diana's Peak, the central ridge, 2700 feet above the sea.

The destruction of the Madeira forests you will remember was by fire. A much more insidious agency has operated with tenfold greater effect in St. Helena, viz., goats. These were introduced in 1513, and multiplied so rapidly, that in 1588 Captain Cavendish states that they existed in thousands; single flocks being almost a mile long.

In 1709, trees still abounded, and one, the native Ebony, in such quantities, that it was used to burn lime with. At this time, however, the Governor of the island reported to the Court of Directors of the East India Company, that the timber was rapidly disappearing, and that the goats should be destroyed for the preservation of the Ebony wood, and because the island was suffering from droughts. He received the laconic reply, "The goats are not to be destroyed, being more valuable than Ebony."

Another century elapsed, and in 1810 another Governor reports the total destruction of the great forests by the goats, which greedily devour the young plants, and kill the old by browsing on their leaves and bark, and that fuel was so scarce that the Government paid for coal (and this in a tropical islet), £2729 7s. 8d. annually. Still, even then, so great was the amount of seed annually shed, so rich the soil, and so rapid the growth of the native plants, that the Governor goes on to say, that if the goats were killed, and the island left to

itself, it would in 20 years be again covered with indigenous vegetation.

About this time the goats *were* killed, but another enemy to the indigenous vegetation was at the same time introduced, and which has now rendered it in all probability impossible that the native plants will ever again resume their sway. Major-General Beatson, then Governor, an active and sagacious officer, proposed and carried out the introduction of exotic plants on a large scale, and from all parts of the world; these have propagated themselves with such rapidity, and grown with such vigour, that the native plants cannot compete with them. The struggle for existence had no sooner begun, than the issue was pronounced; English Broom, Brambles, Willows, and Poplars, Scotch Pines, and Gorse bushes, Cape of Good Hope bushes, Australian trees, and American weeds, speedily overran the place; and wherever established, they have actually extinguished the indigenous Flora, which, as I said before, is now almost confined to the crest of the central ridge.

It is therefore now impossible to distinguish the introduced from the native plants of St. Helena; but most fortunately Herbaria exist, made at the beginning of this century, that to a great extent supply the deficiency. Of these, the most complete was formed by the late Dr. Burchell, the eminent South African and Brazilian traveller, who spent five years on St. Helena, from 1805 to 1810. Unfortunately for science, Dr. Burchell never published, and scarcely allowed any naturalist access to his Herbarium. On his death, last year, his magnificent botanical collections were presented to Kew by his sister, and amongst them I found his invaluable St. Helena Herbarium in a capital state of preservation.

It includes 169 flowering plants, but most unhappily Dr. Burchell has not indicated which are *bona fide* natives, and which have followed the track of men and animals introduced by him, and have thus become quasi-indigenous or naturalised. Some years after Dr. Burchell's visit, however, an eminent

Indian botanist, Dr. Roxburgh, visited St. Helena, and drew up a catalogue of the indigenous, naturalised, and cultivated plants, then existing, carefully indicating the truly indigenous ones that were then surviving. Dr. Roxburgh's collection was much less complete than Burchell's, but by collating the two, and with my own observations made during two visits to the island, I have arrived at a fairly accurate estimate of the number and affinities of the native vegetation remaining.

According to these data, about forty-five indigenous species inhabited the island before Major-General Beatson destroyed the goats, and introduced the European, etc., plants, to which five dubious natives may possibly be added. All are shrubs, trees, or perennial plants; not one is an annual (though introduced annual plants abound, both tropical and temperate). Forty of them are absolutely confined to the island, and five are tropical weeds or seaside plants of very wide distribution.

These forty are absolutely peculiar to St. Helena and, with scarcely an exception, cannot be regarded as very close specific allies of any other plants at all. No less than seventeen of them have been referred to peculiar genera, and of the others, all differ so markedly as species from their congeners, that not one comes under the category of being an insular form of a continental species. Many of them are excessively scarce, being now found in very small numbers, and on single rocks; not a few have never been gathered since Dr. Burchell's visit, some are certainly now extinct, as the beautiful Ebony tree, and probably nearly one-fifth have totally disappeared during the last half-century, or are now all but extinct.

From such fragmentary data it is difficult to form any exact conclusions as to the affinities of this Flora, but I think it may be safely regarded as an African one, and characteristic of Southern extra-tropical Africa. The genera *Phyllica*, *Pelargonium*, *Mesembryanthemum*, *Osteospermum*, and *Wahlenbergia* are eminently characteristic of Southern extra-

tropical Africa, and I find amongst the others scarce any indication of an American parentage, except a plant referred to *Physalis*. The Ferns tell the same tale. Of twenty-six species, ten are absolutely peculiar, all the rest are African, though some are also Indian and American.

The botany of St. Helena is thus most interesting; it resembles none other in the peculiarity of its indigenous vegetation, in the great rarity of the plants of other countries, or in the number of species that have actually disappeared within the memory of living men. In 1839 and 1843 I in vain searched for forest trees and shrubs that flourished in tens of thousands not a century before my visit, and still existed as individuals twenty years before that date. Of these I saw in some cases no vestige, in others only blasted and lifeless trunks cresting the cliffs in inaccessible places. Probably one hundred St. Helena plants have thus disappeared from the *Systema Naturæ* since the first introduction of goats on the island. Every one of these was a link in the chain of created beings, which contained within itself evidence of the affinities of other species, both living and extinct, but which evidence is now irrecoverably lost. If such be the fate of organisms that lived in our day, what folly it is to found theories on the assumed perfection of a geological record which has witnessed revolutions in the vegetation of the globe, to which that of the Flora of St. Helena is as nothing.

ASCENSION.—The islet of Ascension claims a passing notice. It is much smaller than St. Helena, and 600 miles N.W. of it. St. Helena has been called a barren rock, but it is a paradise as compared with Ascension, which consists of a scorched mass of volcanic matter, in part resembling bottle glass, and in part coke and cinders. A small green peak, 800 feet above the sea, monopolises nearly all the vegetation, which consists of Purslane, a Grass, and Euphorbia, in the lower parts of the island, whilst the green peak is

clothed with a carpet of Ferns, and here and there a shrub, allied to but different from any St. Helena one. There are nine Ferns, of which no less than six differ from those of St. Helena, and three of them are entirely confined to the islet.

KERGUELEN'S LAND.—I shall now take you to an island with very different features from any of the above, and whose vegetation appears at first sight to be in discord with all we have yet seen of the relations of oceanic islands to continents; but which actually proves no exception to the rule, that the Floras of these islands are derivative.

Kerguelen's Land, the Isle of Desolation of Cook, is situated in the tempestuous South Indian Ocean, in the latitude of Cornwall, and within the northern limit of floating icebergs. It rears itself from the ocean as a black volcanic mass, girt with sea cliffs, and perennially swept by terrific storms. It is 2170 miles from the nearest continent, South Africa; 4130 from Cape Horn, and 3800 from the nearest of the New Zealand group, these being the southernmost masses of land inhabited by plants.

At a few miles' distance it appears to be absolutely sterile, and on nearing the coast the scenery scarcely improves. A narrow belt of Grass skirts the deep harbours, and above this are brown rounded heaps of a very peculiar Umbelliferous plant (*Azorella Selago*) growing like tufts of a gigantic Moss or Saxifrage. These are succeeded by scattered tufts of Grass and herbs struggling for existence in a most barren soil.

In Cook's Voyages it is written: "Perhaps no place hitherto discovered, in either hemisphere under the same parallel of latitude, affords so scanty a field for the naturalist as this barren spot; for he might assuredly have added ten degrees to its own latitude in the southern hemisphere, and upwards of twenty in the northern, as the limits upon which such a paucity of species exists." And even Cook's account falls far short of the truth, for Spitzbergen, thirty degrees

nearer the Pole, boasts of five times as many flowering plants as Desolation Island.

Captain Cook's naturalist (Dr. Anderson), during his summer stay at Kerguelen's Land, found only eighteen plants in all, Phænogamic and Cryptogamic. During my winter's stay there I found about 150, including all those found by Cook—a most remarkable fact, showing how equable, though tempestuous and severe, the climate must be throughout the year. Of the flowering plants all are perennial, and one of them had a very remarkable appearance; it was a gigantic Cruciferous plant allied to the northern Scurvy Grass (*Cochlearia*), and which we christened the Kerguelen's Land Cabbage, both because of its appearance and because we used it daily as a pot-herb. During 130 days we ate no other fresh vegetable than this, which was served out with the ship's salt junk and pork, and during that time there was not a case of illness of any consequence in a company of 120 officers and men. It hence well merits its Latin name of *Pringlea anti-scorbutica*, the generic name being given in compliment to Sir John Pringle, an eminent writer on that scourge of seamen, the scurvy. This plant was abundant near the sea, and is a well-marked feature in the view of Christmas Harbour which is engraved in Captain Cook's Third Voyage. It is allied to no other known plant in the southern hemisphere, and is as remarkable, whether for its curious habit of growth or its botanical characters, as any of those singular plants which I have indicated as forming peculiar features in the sea cliffs of the Madeiran, Azorean, or Canarian Islands. Like these, too, it tells no tale as to the origin or affinities of the Kerguelen's Land Flora.

It is not so with the other flowering plants; they almost without exception point to the land whence they were derived. The only other peculiar genus on the island (*Lyallia*) is decidedly an Andean form; of the remaining sixteen flowering plants, four are regarded as distinct species peculiar to Kerguelen's Land, but three of them are so nearly allied to

Tierra del Fuego congeners, that they may equally rank as varieties of these, and the fourth stands in the same relation to a New Zealand plant. Of the remaining twelve, ten are Fuegian, of which four are confined to Fuegia and Kerguelen's Land, including the remarkable Umbelliferous plant, which belongs to a group that is otherwise very characteristic of the South American Andes. Five are found in all south circumpolar regions, and one alone is confined to Kerguelen's Land and Lord Auckland's Group. Three are European, and all of these are common English and Antarctic fresh-water plants. They are *Callitriche verna*, *Limosella aquatica*, and *Montia fontana*.

The affinity of the Kerguelen's Land Flora is hence extremely close to the Fuegian; so close, indeed, that it cannot be doubted that it was for the most part derived from thence. And it is all the more remarkable that this relationship should be so strong and unmistakeable, if you consider that the mother country of its Flora is not that which is nearest to it, as was the case with all the other islands we have discussed, but that which is the most distant from it; and indeed Kerguelen's Land is more distant from a continent than any other island in the Atlantic or Indian Oceans.

I have thus endeavoured to bring before you, by conspicuous examples, the chief botanical features of certain oceanic islands, and the nature of the resemblances and differences that subsist between their vegetation and those of the continents nearest to them, or from which their plants appear to have been directly or indirectly derived.

Before proceeding to discuss the theories that have been propounded to account for the stocking of oceanic islands with plants, and for the peculiarities of Oceanic Island Floras, I will recapitulate these briefly. We have seen:

1. That the Flora of no oceanic island which we have considered is an independent one; that in all cases it is quite

manifestly closely allied to some one continental Flora, and that however distant it may be from the mother continent, and however it by so much approximates to another continent, it never presents more than faint traces of the vegetation of such other continent. Thus the Azores, though 1000 miles nearer to America than Madeira has not even so many American types as Madeira has. St. Helena, though 1000 miles nearer to South America than is any part of the African coast, contains scarcely any plants that are even characteristic of America; and Kerguelen's Land, though far more distant from Tierra del Fuego than it is from Africa, Australia, or New Zealand, is almost purely Fuegian in its Flora.

2. The Floras of all these islands are of a more temperate character than those of the mother continents in the same latitude; thus, Madeira and the Canaries have a Mediterranean Flora, though they are respectively 5° and 10° south of the principal parallel of the Mediterranean region; the affinities of the St. Helena Flora are strongly South African; and the Flora of Kerguelen's Land, in lat. 48° , is what we might expect to meet with in Fuegia, were the American continent produced southward to lat. 60° .

3. All contain many and great peculiarities, distinguishing them from the continental Floras; and these admit of the following classification:—

a. Plants peculiar to the islands and betraying no affinity with those of the mother continent, as the Laurels, etc., of Madeira and the Canaries and Azores; the arborescent *Compositæ* of St. Helena, and the Kerguelen's Land Cabbage.

β. They contain certain genera that are very different from those of the mother continent, but are evidently allied to them; and others but slightly different. They contain species that are very different from, but allied to those of the mother continent; and others that are but slightly different from continental; and they contain varieties in the same categories.

INSULAR FLORAS

4. As a general rule, the species of the mother continent are proportionally the most abundant, and cover the greatest surface on the islands. The peculiar species are rarer, the peculiar genera of continental affinity are rarer still; whilst the plants having no affinity with those of the mother continent are often very common, in the temperate islands especially—at least under the conditions which the island vegetation now presents.

5. Indigenous annual plants are extremely rare or absent; but recently introduced annuals are very abundant in those islets that have been frequented by man.

I now come to the most difficult part of my task, which is to discuss in a brief space of time the hypotheses that have been invented by naturalists to account for the presence of continental plants in oceanic islands, and for those various differences between insular and continental Floras that I have indicated.

These hypotheses are as yet unverified and insufficient; neither geological considerations, nor botanical affinity, nor natural selection, nor all these combined, have yet helped us to a complete solution of this problem, which is at present the *bête-noir* of botanists. Oceanic islands are, in fact, to the naturalist, what comets and meteorites are to the astronomer; and even that pregnant doctrine of the origin and succession of life which we owe to Darwin, and which is to us what the spectrum analysis is to the physicist, has not proved sufficient to unravel the tangled phenomena they present.

There are only two possible hypotheses to account for the stocking of an oceanic island with plants from a continent: either seeds were carried across the ocean by currents, or the winds, or birds, or similar agencies; or the islands once formed part of the continent, and the plants spread over intermediate land that has since disappeared.

To a superficial observer either of these causes may appear admissible, or feasible and sufficient; but the naturalist, who

takes nothing for granted, finds insuperable obstacles to the ready acceptation of either. Upon one fundamental point most of the advocates of both hypotheses are agreed, namely, that those plants which are common to the islands and continents were not independently created in both localities, but that they did pass from one to the other; and another will probably gain ready credence, viz., that those peculiar insular plants which have no affinity with continental ones, are relics of a far more ancient vegetation than now prevails on the mother continents. This latter is a most important point to be established. I have given you my reasons, derived from the conditions under which the Atlantic island plants are found in the Madeiran group, for assuming that they represent the wreck of a very ancient Flora; the proof of it lies in the fact that the same plants, or their congeners or close allies, are found abundantly fossil in the tertiary strata of many parts of Europe; it is an indisputable fact that the vegetation of Europe has undergone a complete revolution within the lifetime of these Atlantic Island species, which, from their foreign aspect, arrest our attention so forcibly in the forests of the Canaries, Madeira, and Azores; and that these are the living witnesses of that period, when trees, now characteristic of Asia and America, formed the forests of our own continent; and that they owe their preservation up to the present time to their insular position. They no doubt originally migrated from the continent of Europe* to the islands, and have since been driven out of Europe by the northern and eastern Floras that now replace them there; but this was at an immensely remote period, when the condition of both islands and continent may have been very different from what they now are.

* It is not necessary here to dwell on the doctrine of Unger, Heur, and others, that these, or most of these types were derived from the westward; a doctrine from which I totally differ, and which I consider refuted by Prof. Oliver's masterly review of the question (*Nat. Hist. Review*, ii. p. 149, 1862).

The hypothesis which suggests that there was an old continental extension, which, by including the islands, thus enabled them to receive the continental plants without trans-oceanic migration, first found a scientific exposition in the ingenious essay of my friend, the late Prof. E. Forbes, "On the Geological Relations of the existing Fauna and Flora of the British Isles," read before the British Association at Cambridge in 1845. In this Prof. Forbes maintains that the Flora of Britain was mainly derived from the continent of Europe, when our islands were an integral part of the latter, that is, before the cutting out of the English Channel and German Ocean; an hypothesis that is very well supported, and I believe almost universally accepted by both naturalists and geologists. He further accounts for the peculiar colony of Pyrenean plants that is found in West Ireland by an ancient continental extension across the Bay of Biscay. And finally he revives the hypothesis of the Atlantis of the ancients, in the shape of a continental extension of the western shores of Europe and Asia, reaching nearly one-third across the Atlantic Ocean, so as to include in its wide embrace the Azores, Madeira, and Canary Islands. As the arguments in favour of this view have been all laid before the British Association by its author, I cannot dwell upon them here; nor is this necessary, as I shall have to allude to them in discussing the counter hypothesis of trans-oceanic migration.

This, which was previously nothing more than a generally accepted guess, or assumed probability, first received a scientific exposition from Mr. Darwin, in his "Origin of Species," only seven years ago. And I would here beg you to understand clearly, that this inquiry is not a part and parcel of Mr. Darwin's theory of the origin of species; variation and natural selection are not mechanical aids to the transport of plants from a continent to an island, though they may affect our views of the results of such transport, which is quite another matter. I have to-night given you facts regarding Oceanic Floras that strongly support Mr.

Darwin's derivative theory of species; and in like manner Mr. Darwin, believing in trans-oceanic migration on grounds altogether independent of his theory of species, uses the results flowing from such a view in support of this theory. Thus far he goes, and so far it is our business to go with him, and to scrutinise his method.

Mr. Darwin brings many powerful arguments in support of trans-oceanic migration; starting from the fact admitted by all, that some means of transport are always in operation, he reduces the matter to a question of extent, and amount of agencies, and of time during which they may have operated; he shows that birds do carry seeds in their feet and beaks and in their stomachs, and that such islands as the Canaries and Madeira are stocked with exclusively European species of land birds; that we have annually a trans-oceanic transport of American birds to Europe and of European birds to Greenland; that fresh-water fish devour seeds, and that if these become the prey of birds, the contents of their stomachs may thus be deposited on distant islands; that dust is blown 1000 miles over the ocean, whilst the seeds of many plants are no larger or heavier than particles of dust.

Then, with regard to strictly marine agencies, whereas it was supposed that exposure to salt-water must be invariably fatal to seeds, he has shown by experiment that many seeds will survive immersion in salt water for periods sufficient to permit their being transported several hundred miles by currents without losing their vitality: and that they are thus transported I have given you a conspicuous instance in the *Entada* seeds (which, by the way, were sent me by Mr. Darwin), and which, after floating 3000 miles from the West Indies to the Azores, germinated at Kew; to which he adds, that all the Coral Islets, which no one supposes to have been ever connected with continents, are well stocked with plants by marine agency.

Of negative evidence in favour of this view, Mr. Darwin adduces the fact that oceanic islands are poor in species, and

that whole groups of continental plants are absent from them, which should not be the case had there been continental extension ; that land mammals and Batrachians are absent from all oceanic islands, though winged mammals, as bats, together with birds, insects, and other transportable terrestrial creatures, are present in more or less abundance ; that if we demand continental extension for some islands, it must be admitted for all, which is, according to his views of the permanence of the general outlines and dispositions of the continents and sea-beds, during the later geological epochs, quite inadmissible.

Lastly, the oceanic islands which I have to-night described, and almost all others known to us, are volcanic, which would imply that the submerged continents were volcanic too, a position we have no evidence in support of, and which is in itself extremely improbable.

This is but a brief outline of Mr. Darwin's arguments in favour of trans-oceanic migration ; such as it is, it shows a power and skill of bringing facts to bear, and a fertility of invention in devising means of verifying these facts, that almost compel me to agree with him in regarding oceanic transport to be, in the present state of science, the principal and most probable means by which oceanic islands have been stocked with plants ; I say most probable, for I should add that Mr. Darwin does not put this view forward as more than an opinion to which he inclines ; with that candour which characterises all his writings, he will not let even the corroborative evidence which his derivative theory affords him, weigh when estimating the value of the two hypotheses.

But though Mr. Darwin's explanations cover many of the requirements of our problem, and may eventually prove to satisfy all, there are great difficulties in the way of its full acceptation.

First, as regards transport by winds, ocean currents, etc., much that we know of the directions of these agencies in the

North Atlantic is in favour of their bringing American and not European plants to the Azores; and yet we find even fewer American types in this group than in Madeira and the Canaries. This objection is very partially met by the fact that the Azores are nearer Europe than America, and that American plants when brought into competition with European are beaten in the contest, and that many of the American types were also European during a comparatively recent geological epoch. For the superior American currents of migration should at least keep up some supply.

Nor is it sufficient to quote the fact that the birds of these islands are (as Dr. Sclater assures me is the case) almost identical specifically with European ones, and are thus the living proofs of the migration being from Europe. No doubt they are proofs of bird transport being from Europe, but not necessarily of plant transport; for since the plants are considerably different specifically, and the birds not at all, it may be argued that the birds and plants do not come under the same category. Mr. Darwin answers this objection by the consideration that the migration of birds being continuous and frequent, and the individuals surviving and breeding, they keep up the specific type, and do not give origin to local varieties; whilst the transport of seeds being casual and rare, and very few surviving, these not being crossed by the original stock, in the process of time give rise to varieties, etc., and do not perpetuate the continental races.

So, too, it is with St. Helena and Ascension—they have no land birds, but an African vegetation; and though nearly midway between Africa and America, they have scarcely a single American type of flowering plants: and Kerguelen's Land has a Flora of whose elements most have emigrated not from the nearest land but from the most distant.

Another difficulty is presented by the extreme rarity of some of the plants common to several of the North Atlantic Islands; take, for example, that remarkable Canarian tree, *Beaucornia caudata*, of which only two individuals have been

found in the mountains of Madeira, and these a male and a female. It is almost inconceivable that individuals of both sexes should have been transported within the same lifetime from the Canaries to so great a distance; and so with the other peculiar and rare plants common to these groups; intermediate masses of land, as the Salvages (supposing these once to have been larger), and on which such plants may have abounded, afford the only conceivable means of inter-insular transport; and if intermediate islands are granted (and Mr. Darwin freely grants these), why not continents?

It is admitted that certain large islands, which lie too near the continents to come under the technical definition of oceanic, and which do contain terrestrial Mammals, as Great Britain, Ceylon, Madagascar, Japan, the Falkland Islands, etc., were once united to the continents to which they are adjacent, and thus received their immigrants; and an examination of the Floras of some of these exceedingly complicates the question, for unlike oceanic islands, many of these do contain, besides the plants of the adjacent continents, many types of those peculiar to the opposite continent—Ceylon containing Malayan plants not found in the Indian Peninsula, Japan possessing N. American plants not found in China; and Madagascar, Bornean and Javan plants not found in continental Africa. We should thus be forced to admit that whereas great islands which are peopled by plants through direct communication with the adjacent continents, do receive immigrants from other most distant continents, the little islets that are much nearer the continent, and over whose course the currents of migration must have swept, have been exempted from its effects. Here, again, as it appears to me, the only answer is by an appeal to the very different rates in which the vegetation has changed in the islands and the continents during comparatively recent geological periods.

Then, too, we have conspicuous examples of islands not having profited by migration from the nearest continent,

where it would be most expected they should. Take New Zealand: it does contain certain Australian species and types, but these are not the most common, or most likely to have arrived by trans-oceanic migration. The arboreous vegetation of Australia mainly consists of Gum trees and leguminous plants, which cover three-fourths of the wooded parts of that continent, but not one is found in New Zealand; yet the seeds of the Gum trees are very minute, are shed in inconceivable quantities, retain their vitality long, and both Gum trees and Acacias, when introduced by man into New Zealand, become naturalised at once, and actually displace the indigenous vegetation of the island.

Even if we grant, with Mr. Darwin, that the specific and sub-specific change between the Floras of oceanic islands and continents is due to the new relations into which the continental plants are brought in the narrow areas that islands present, and the ensuing sharper struggle for existence, how does it come about that the plants of the Azores, which islands are 750 miles from Europe, are less changed than those of Madeira, which is only 300? This objection seems to me to be imperfectly met by the hypothesis that the nearer island, receiving more immigrants, exhibits the sharper struggle; for this same cause should rather replenish the island with identical forms, and by cross-fertilisation tend to keep them more specifically true; as was assumed to account for the European birds of the Madeiran group being unchanged, whilst the plants of the same group have changed.

With regard to the objection that oceanic islands are volcanic, and hence probably not the mountain-tops of sunk continents, and that they contain no fossil mammals, we have in the Malay Archipelago vast areas of land which, if submerged (and they are exposed to constant subsidences and risings) would leave only isolated volcanic peaks, such as oceanic islands present. Were such an area to be submerged leaving exposed the volcanic peaks of Java and the Moluccas, etc. etc., should we expect to find either recent or fossil

terrestrial mammals upon them? Nor should it be overlooked that, as a general rule, islands diminish in size and numbers towards the centres of the great oceans, which, taken with the admission that the great islands adjacent to the continents were previously united to them, would favour the hypothesis that all may have been so. And finally, we have instances of continental distribution presenting facts so analogous to oceanic and hitherto so utterly inexplicable on any hypothesis of migration that does not embrace immense geological changes, that we can scarcely avoid coupling the phenomena they present with those of oceanic islands.

(On the other hand, to my mind, the great objection to the continental extension hypothesis is, that it may be said to account for everything, but to explain nothing; it proves too much; whilst the hypothesis of trans-oceanic migration, though it leaves a multitude of facts unexplained, offers a rational solution of many of the most puzzling phenomena that oceanic islands present—phenomena which, under the hypothesis of intermediate continents, are barren facts literally of no scientific interest—are curiosities of science, no doubt, but are not scientific curiosities.

Thus, according to the hypothesis of trans-oceanic migration, and the theory of the derivative origin of species, we can understand why the ancient types, like ancient races of mankind, which have disappeared before the steady forward pressure of superior races on the continents, should have survived on the islands to which but few of the superior race had penetrated—we can understand how it comes about that so many continental species and genera are represented on the island by similar but not identical species and genera, and that there is such a representation of genera and species in the separate islets of the group; we can understand why we find in the Atlantic island Floras such a graduated series of forms ascending from variety to genus

without those sharp lines of specific distinction that continental plants exhibit; why whole tribes are absent in the Islands; why their Floras are limited, and species are few in proportion to genera; why so many of their peculiar genera tend to grotesque or picturesque arborescent forms; and many other minor facts which it would weary you to enumerate.

And if many of the phenomena of oceanic island Floras are thus well explained by aid of the theory of the derivative origin of species, and not at all by any other theory, it surely is a strong corroboration of that theory. Depend upon it, the slow but steady struggle for existence is taking advantage of every change of form and every change of circumstance to which plants no less than animals are exposed; and that variation and change of form are the rules in organic life, is as certain as that definite combinations and mathematical proportions are the rules in the inorganic.

By a wise ordinance, it is ruled that amongst living beings like shall never produce its exact like; that as no two circumstances in time or place are absolutely synchronous, or equal, or similar, so shall no two beings be born alike; that a variety in the environing conditions in which the progeny of a living being may be placed shall be met by variety in the progeny itself. A wise ordinance it is, that ensures the succession of beings, not by multiplying absolutely identical forms, but by varying these, so that the right form may fill its right place in Nature's ever varying economy.

The acceptance of general principles, whether in the physical or biological sciences, has always been a slow process, and I look for no exception in the case of this of the derivative origin of species. The physical sciences, however, have the start of the biological, scientific progress in them having commenced several centuries ago, whereas it is hardly one century since Botany and Zoology first became the subjects of exact scientific study. Before that period not

a system had been invented, and the principles of life, whether in their structural or functional aspects, have for the most part been discovered within the lifetime of many of us here, and the knowledge of them is not yet recognised as a branch of a liberal education.

You have all read of uncivilised races of mankind that regard every month's moon as a new creation of their gods, who, they say, eat the old moons, not for their sustenance, but for their glory, and to prove to mortals that they can make new ones; and they regard your denial that their gods do monthly make a new moon as equivalent to denying that they could do so if they would.

It is not so long since it was held by most scientific men (and is so by some few still) that species of plants and animals were, like the savages' moons, created in as many spots as we meet them in, and in as great numbers as they were found at the times and places of their discovery. To deny that species were thus created was, in the opinion of many persons, equivalent to denying that they could have been so created.

And I have twice been present at the annual gatherings of tribes in such a state of advancement as this, but after they had come into contact with the missionaries of the most enlightened nations of mankind. These missionaries attempted to teach them, amongst other matters, the true theory of the moon's motions, and at the first of the gatherings the subject was discussed by them. The presiding Sachem shook his head and his spear. The priests first attacked the new doctrine, and with fury; their temples were ornamented with symbols of the old creed, and their religious chants and rites were worded and arranged in accordance with it. The medicine men, however, being divided among themselves (as medicine men are apt to be in all countries), some of them sided with the missionaries—many from spite to the priests, but a few, I could see, from

conviction—and putting my trust in the latter, I never doubted what the upshot would be.

Upwards of six years elapsed before I was again present at a similar gathering of these tribes; and I then found the presiding Sachem treating the missionaries' theory of the moon's motions as an accepted fact, and the people applauding the new creed!

Do you ask what tribes these were, and where their annual gatherings took place, and when? I will tell you. The first was in 1860, when the Derivative doctrine of species was first brought before the bar of a scientific assembly, and that the British Association at Oxford; and I need not tell those who heard *our* presiding Sachem's address last Wednesday evening, that the last was at Nottingham.